GENETIC STUDIES IN THE GENUS MELILOTUS

BY

EDGAR EMERSON HARTWIG

B.S., University of Minnesota, 1937

M.S., University of Illinois, 1939

AN ABSTRACT OF A THESIS

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS

FOR THE DEGREE OF DOCTOR OF PHILOSOPHY IN

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GENETIC STUDIES IN THE GENUS MELILOTUS

Although sweet clover is one of the most widely grown legumes in the corn belt states for soil improvement and pasture purposes, the elimination of certain undesirable features would enhance its value as a forage crop. Many strains now grown are too early maturing to fit properly into a well balanced pasture program. Late maturity, disease resistance, increased palatability, and ability to produce a seed crop are characteristics required in sweet clover as a forage crop well adapted to the more humid section of the corn belt.

Studies have been carried on to investigate the characteristics and variations in existing strains of sweet clover, the effects of self-pollination, and the inheritance of characters in controlled crosses. This information will be of value in developing improved varieties.

Variability and Correlation Studies

Spaced second year plants of five varieties of *M. alba:* Madrid White, Iowa Late, Illinois Commercial, Ohio Evergreen, and Sangamon; and one variety of *M. officinalis* were studied for variations in height, date of first bloom, stem number, leaf size, leaf color, leafiness, and habit of growth during the growing seasons of 1937 and 1938. Height comparisons showed Madrid Yellow to be shorter than the varieties of *M. alba.* Ohio Evergreen was the tallest of the varieties of *M. alba.* The variability of the different varieties for height was quite similar as determined by the coefficient of variability.

The varieties compared differed widely in date of first bloom. Madrid Yellow for which the mean date of first bloom was June 4 in 1937 and May 30 in 1938, was earlier than the varieties of *M. alba.* Madrid White, Iowa Late, and Illinois Commercial were very similar in time of first bloom, the mean date of first bloom being in the third week in June. Ohio Evergreen and Sangamon were about two weeks later than the three varieties previously mentioned. The range of first bloom within each variety was from 14 to 21 days. The later varieties showed greater variability than the earlier varieties.

Data on stem size, stem number, leaf size, leaf color, leafiness, and habit of growth are estimates of these plant characters made on a numerical basis with a score of 5 considered as average, and plants differing from this were scored higher or lower on a 1 to 10 basis.

Percent of leaves was determined by harvesting two stems from each of 50 spaced plants when the variety was in an early bloom stage. Madrid Yellow with a mean leaf percentage of 37.5 was the leafiest variety, while Ohio Evergreen with a mean leaf percentage of 28.7 had the lowest percentage of leaves. However, the stems of Ohio Evergreen were harvested, and leafiness determined there from, one month later than those of Madrid Yellow.

Degree of association between characters was measured by means of the correlation coefficient. Characters compared were (1) percentage of leafiness of first year growth and percentage leafiness of the second year growth, (2) height of first year growth and height of second year growth, (3) estimate of leafiness in the second year and percentage leafiness, and (4) mature height and percentage leafiness in the second year. For the most part correlation coefficients obtained were too low for significance; however, a highly significant negative correlation was obtained for each of the six varieties when mature height and percentage leafiness of the second year growth were compared.

Effects of Self-Pollination

Effects of self-pollination in sweet clover were determined by comparing open-pollinated and selfed progenies of single plant selections. These were compared in the second season of growth for mature height, stem number, date of first bloom, seed production, and disease reaction. Selfed seed was obtained by bagging a portion of the selected plant in a 9 by 18 fine mesh cotton bag to exclude insects. Advanced selfed generation seed was obtained by growing plants in the greenhouse during the winter months. In this study were included comparisons for 1939 in 13 *M. officinalis* and 49 *M. alba* families; and for 1940, comparisons within 1 *M. taurica,* 2 *M. suaveolens,* and 40 *M. alba* families. The number of plants grown from families varied from 20 to 80 plants each of open-pollinated and S_1 seed and from 10 to 20 plants of each S_2 or S_3

line. Open-pollinated and selfed progenies were compared by families, by varieties, and by species.

Of the comparisons made in *M. alba* between open-pollinated and S_1 populations, all but one showed a decrease in height due to selfing, ranging from 1 to 49 percent with a mean decrease of 16 percent. A further decrease in height of approximately 10 percent occurred in the S_2 and S_3 generations. Stem number showed little change as a result of selfing. S_1 progenies were two to six days later than open-pollinated sister progenies when the mother plants selected were later than the surrounding plants. S_2 and S_3 progenies flowered at approximately the mean of the parent type. Approximately 60% of the plants grown from open-pollinated seed were classified as good seed producers, while only 30% of the S_1 plants and 25% of the S_2 plants were similarly classified. Selfed plants showed a higher degree of black stem infection in 1939 and greater mortality in both 1939 and 1940 than the open-polinated plants. Uniformity for either resistance or susceptibility to disease was demonstrated in S_2 lines.

In *M. officinalis* the mean height of the S_1 population was only 70% as great as that of the open-pollinated population. Stem number of the selfed population was reduced below that of the open-pollinated population. Seed production was very sparse upon selfed plants; 88% of the open-pollinated plants were classified as good seed producers, while 81% of the S_1 plants were classified as poor seed producers.

In the species *M. suaveolens* and *M. taurica,* marked differences were apparent among and within S_2 progenies indicating segregation and recombination of genes for growth and vigor.

This study has given evidence that loss of vigor accompanies selfing, and that crossing plays a major role in the maintenance of vigorous growing strains in the species of Melilotus studied. The probability of isolating a desirable inbred line as vigorous as the common strains of sweet clover seems remote. Therefore, the most satisfactory method of procedure in a breeding program should be to isolate a number of inbred lines carrying favorable characters and combining these to make a synthetic variety.

Inheritance of Characters

Data are presented on the inheritance of growth habit, cotyledon color, cup leaf, and time of first bloom, as well as on hybrid vigor of F_1 plants. Two "dwarf branching" types were studied, F. C. 13074 and F. C. 89911. Both of these types were crossed with the common type of *M. alba,* with each other, and with Alpha which is also a dwarf branching type. Each of the dwarf branching types differs from the common growth type by a single gene, but each has a different gene determining the dwarf branching character. These genes have been symbolized: d_1 — Alpha; d_3 — F. C. 13074; and d_4 — F. C. 89911.

Further evidence is given to show that green cotyledon is a simple recessive to yellow cotyledon. However, when the green cotyledon type is used as the maternal parent the F_1 cotyledon is usually of the same shade of green as the maternal type, but under some environments the F_1 cotyledon is a yellowish green. The symbolism YGI of the garden pea for cotyledon color is suggested. The gene I, which causes green pigment to fade at maturity is the only one assumed to be segregating in sweet clover.

A cup leaf character was isolated and described. This character behaves as a simple recessive to the normal leaf. The gene involved is symbolized (c). In a cross involving the three characters, cup leaf, cotyledon color, and growth habit of F. C. 13074, the genes c, i, and d_3 were found to follow independent assortment.

Early flowering was found to be partially dominant to late flowering. The F_1 plans from crosses of non-related S_1 plants exceeded the taller parent in height in 9 of 11 crosses and nearly equalled the height of the taller parent in the 2 remaining cases. With regard to seed production, 7 F_1 populations surpassed the better parent and the remaining 4 were equal to the better parent.

VITA

The writer was born on a farm near Wheaton, Minnesota, August 26, 1913, and lived there until he entered college. He attended the public schools at Wheaton, Minnesota, and was graduated from the Wheaton High School in June, 1931. After being engaged in farming with two older brothers for nearly three years, he matriculated at the University of Minnesota in January, 1934, where a curriculum in Agricultural Science was followed, with Agronomy and Plant Genetics as the major fields. The degree of Bachelor of Science was conferred in June, 1937.

An appointment as Agent with the U. S. Department of Agriculture was accepted in June, 1937. Since that time, the writer has been carrying on sweet clover improvement and genetic studies in cooperation with the Illinois Agricultural Experiment Station, and has also been enrolled in the graduate school of the University of Illinois. He received the degree of Master of Science in Agronomy in February, 1939. Further graduate studies have been carried on with a major in Agronomy, placing special emphasis on plant breeding and plant genetics, and a minor in Botany, emphasizing plant pathology and plant physiology.

Fraternal affilations include Alpha Zeta, Gamma Sigma Delta, and Sigma Xi.

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